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environment and the behavior of the macronucleus and that the macronucleus assumes different shapes and appearances under different cultural conditions.

Is this amicronucleate paramecium able to exist indefinitely without conjugation involving a micronucleus and without reorganization of nuclear material, or is there another type of reorganization in this race? A nuclear reorganization, if present, must evidently be of a different type from that described by Erdmann and Woodruff.

These and similar problems are interesting, not only in themselves, but because *Paramecium* has been studied in great detail by Jennings and others with reference to the occurrence of cytoplasmic variations. The amicronucleate race, however, is important because the variation is one of nuclear structure. The importance and interest of the study is increased by the fact that the micronucleus is usually considered to be an aggregation of generative or hereditary chromatin and the body which supposedly initiates reproductive processes of all types and from which, in sexual reproduction, the new nuclei are formed.

EUGENE M. LANDIS

ZOOLOGICAL LABORATORY,
UNIVERSITY OF PENNSYLVANIA

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NOTE ON THE OCCURRENCE OF A PROBABLE SEX-LINKED LETHAL FACTOR IN MAMMALS

THE occurrence of sex-linked lethal factors in *Drosophila* is a matter of common knowledge to most biologists. Since mammals have an essentially similar type of sex determination in so far as their dimorphism of sperm is concerned, it is theoretically possible that sex-linked lethal factors should occur among them.

Inasmuch as only a few sex-linked factors of any sort are known in laboratory mammals where numerous other genetic differences have been recorded, breeding tests of linkage relations by ordinary methods are precluded. The first indications of a sex-linked lethal factor would therefore be expected to consist of an abnormal sex ratio at birth and a reduction in the size of litters.

Such conditions are met with in certain Japanese waltzing mice derived from a remarkably closely inbred race. This particular strain of Japanese mice has been inbred from the descendants of a single pair of animals for approximately fourteen years. The animals are difficult to raise and the litters are frequently distinctly smaller than those of non-waltzing mice of inbred races. The great majority of animals of this strain have been bred by Mr. George Lambert of Boston, who has provided adult or young adult animals to the writer for several years. Mr. Lambert is now engaged in recording sex ratio data at the birth of litters and states that at present an excess of females is being produced in his stock. While awaiting increased numerical data from his records, however, it appeared advisable to make a short note of the sex ratio and behavior of this strain in the animals raised under controlled observation.[1] The sex ratio of inbred non-waltzing mice is 103.1 ± 2.8, showing a slight excess of males. The sex ratio obtained from Japanese waltzing race of the Lambert strain is 53.2 ± 5.7. The difference between these ratios is 7.9 times its probable error and is certainly significant.

Since recessive sex-linked lethal factors are transmissible through a female to one half of her male offspring, the sex ratio among the progeny of females carrying sex-linked lethal factors should be theoretically 50.0. Males of the Japanese waltzing race can not, of course, transmit the lethal factor, since if they possessed the factor it would result in their death. If then animals of the Japanese waltzing race are crossed with non-waltzing mice of a race presumably free from lethals, the reciprocal crosses should give markedly different sex ratios. Such is actually the case. Non-waltzing females by Japanese waltzing males should give a sex ratio free from the effect of lethal factors. The observed sex ratio in the F_1 generation of this cross is 118.2

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[1] Dr. H. J. Bagg, of the Memorial Hospital, New York City, has kindly placed at my disposal data collected by him while breeding Japanese waltzing mice of the same (Lambert) strain. These data are included with my own in this publication.

± 3.8 and in the F_2 generation 113.3 ± 3.0. The combined ratios are 115.9 ± 2.7. The significant excess of males above that found in the inbred non-waltzing stock is a common result of hybridization. The reciprocal cross gives a most interesting contrast. When Japanese waltzing females are crossed with non-waltzing males the sex ratio is 44.0 ± 7.4. This differs from the sex ratio of the reciprocal cross by 8.9 times the probable error of the difference.

Certain other evidence is obtainable from the results of mating Japanese waltzing females or their female descendants with hybrids of the F_1 or back cross generation. Such crosses give opportunity for a lethal factor to be transmitted and to express itself. We should expect, therefore, that an excess of females would be obtained in the progeny of such crosses. Such is actually the case, the ratio being 78.7 ± 2.9. The exact ratio to be expected would depend upon the numerical relation of young in a given population, obtained from homozygous normal females, to those from females carrying the lethal factor.

The size of litters given by Japanese females irrespective of the sire is distinctly smaller than that of litters from non-waltzing females. The average of 58 litters from Japanese waltzing females is 3.38 and from non-waltzing females (100 litters) 5.93. The litters from Japanese females are therefore .57 times the size of those from non-waltzing females. This result is in general accordance with the presence of a sex-linked lethal factor. x^2 test of the frequency distributions of litters in the two cases shows that the odds are less than one in 1,000,000 that they are the same.

While it is realized that the above evidence is preliminary, its entire consistency and the controlled nature of the material makes it seem likely that *the observed figures indicate the presence of what is apparently the first case of sex-linkage in rodents and of a sex-linked lethal factor in mammals.* The possible exceptions to this statement[2] are to be found in the case of hemophilia recently reviewed by Whitman[3] and in the possible difference in reciprocal crosses between *Epimys rattus* and *Epimys alexandrinus* reported by De l'lsle and reviewed by de Meijere.[4]

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[2] Progressive muscular atrophy in man has a lethal action. Its action is, however, so delayed that it seems scarcely to fall into the same category with what have hitherto been considered as sex-linked lethals.

[3] *Jour. Cancer Research,* 1919, 4, 181.

[4] *Archiv. f. Rassengesell. u. Biol.,* 8, 697.

In order to explain the case reported by Whitman an entirely new and unsupported behavior of the lethal factor is hypothesized. This consists in a supposition that females possessing two does of the lethal die. Inasmuch as a female with two doses of a sex-linked lethal could not be formed except by mutation, provided the relations observed in *Drosophila* hold true, the presence of a sex-linked lethal factor of the accepted type does not appear to be strongly supported. In the case of the rats a simple statement of a difference in reciprocal crosses is the sole evidence. In this case no lethal action is apparently involved; but sex-linkage might possibly account for the result. Until actual experimental evidence on this matter is available, however, it seems as though it was not sufficiently definite to be considered as having previously established the existence of sex-linkage in rodents.

C. C. LITTLE

CONCERNING THE FOSSILIZATION OF BLOOD CORPUSCLES

RECENTLY, while studying a series of microscopic preparations of fossil material in connection with paleopathology, I observed in sections of a dinosaur bone (possibly *Apatosaurus*) which I had collected in the Como beds of Wyoming in 1906, some ovoid bodies, arranged around the periphery of vascular spaces and Haversian canals, which looked remarkably like blood corpuscles. Close scrutiny of the available material, however, did not satisfy me that the objects might not be the products or by-products of incomplete crystallization. The majority of the bodies had the size and shape of modern reptilian erythrocytes; the nucleus of course not being evident, since only the outward form of the corpuscle was to be seen. Other bodies, apparently similar, were irregular in shape and hard to distinguish structurally from the regular bodies. These latter, however, may be masses composed of several corpuscles which had become agglutinated.

Not being satisfied with the results of my observations, I should not have published anything about it had I not seen in a memoir by Seitz[1] a description of similar bodies in sections of normal

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[1] Adolf Leo Ludwig Seitz, 1907, "Vergleichenden Studien über den mikroskopischen Knochenbau fossiler und rezenter Reptilien und dessen Bedeutung für das Wachstum und Umbildung des Knochengewebes im allgemeinen," *Nova Acta. Abh. der Kaiserl. Leop.-Carol. Deutschen Akad. der Naturforscher. Halle,* Bd. LXXXVII, No. 2, 329–330, Tab. XXI, Fig. 61, where the corpuscles are shown in a photomicrograph in 365 diameters.